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IMPERIAL MYCOLOGICAL INSTITUTE 30 MAY 1939

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
COLUMBIA, MISSOURI

CIRCULAR 135 (Reprinted August, 1931) APRIL, 1925

Cedar Rust of Apples in Missouri

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Fig. 1.—Reading from left to right: (1) Cedar galls on red cedar; (2) Cedar rust injury on apple leaf; (3) Cedar rust injury on apple fruit.

Serious injury to the apple from the fungous disease commonly known as cedar rust or apple rust dates back to the beginning of the commercial apple industry in Missouri. A study of the disease also shows that it has done much more damage during some years than others. The evidence at present indicates that cedar rust has steadily grown worse for the last five years in orchard sections of the State where the red cedar is abundant. It would be difficult to make a fairly accurate estimate of the yearly damage done to the apple crop. From the information available, however, it is conservative to estimate the annual loss of the apple fruit in Missouri at $25,000 to $50,000. This does not take into account loss of tree vigor by premature defoliation, reduction in the size of the affected trees and the shortening of the life of the orchard.

Cedar rust is found in practically all of the orchard sections of the central, eastern and southern portions of the United States. The disease appears, however, to be most serious in the southern part of the apple growing districts of the several eastern and central states. The states reporting the greatest injury are as follows: West Virginia, Alabama, Virginia, Indiana, Illinois, New York, Ohio, Kentucky, North Carolina, Missouri, Kansas, Arkansas, Nebraska, Iowa and Wisconsin. In the central and eastern parts of the country, wherever apples grow in the vicinity of the red cedar, the disease is generally serious and of great economic importance.

SUSCEPTIBILITY OF APPLE VARIETIES

The different varieties of apples vary greatly in their resistance to cedar rust. In fact, the different commercial sorts are more marked with reference to varietal resistance to cedar rust than to most fruit diseases. In general, the varieties most susceptible to the disease under Missouri conditions are as follows: York, Rome, Wealthy, Jonathan, Benoni, Red June, Minkler, Smith Cider and Payne's Late Keeper. The most resistant varieties may be listed as follows: Winesap, Stayman, Arkansas, Grimes, Transparent, Maiden Blush, Northwestern Greening, and Duchess. Ben Davis, Gano, Aikin and several other varieties are considered moderately susceptible.

Fig. 2.—Cedar rust on the upper surface of apple leaf.

EFFECT ON LEAVES

The first appearance of the disease on the leaves is indicated by small, light yellow spots. These spots gradually become larger and usually of a brighter orange color. Near the center of the orange colored spots on the upper sides of the leaves very small, dark dots appear known as pycnidia. Beneath the yellow spots on the under sides of the leaves are formed cup-shaped structures, the aecia. These produce spores called aeciospores during the summer, July and August, which are carried by the wind to the cedar trees. The

leaf tissue, though affected by the fungus, does not die readily, but generally remains alive during the greater part of the growing season. The region of the leaf in which the infection occurs becomes swollen or enlarged and when the leaf is seriously affected the whole leaf is enlarged considerally and the edges of the leaves may curl back in an unusual manner.

Leaf infection occurs early in the season when the leaves are small. Exact dates cannot be foretold accurately, as the infection each season depends greatly upon weather conditions. In general, for South Missouri the first infections occur about April first or at the time when the first apple blossoms open; and the period of infection usually extends until the latter part of May or first week in June. For Central and North Missouri infections occur from a week to 10 days later. As the leaves grow older, they gradually develop a resistance to the disease, and rarely does leaf infection occur after the first of June in Missouri.

EFFECT ON FRUIT

The disease affects the fruit in much the same way that it affects the leaves, although the yellowish or orange colored spots are larger. Cup-shaped pustules or aecia resembling those on the lower part of the leaf surface are developed upon the fruit. The cedar rust spots on the apple generally occur near the calyx end. The spores which are carried by the wind undoubtedly alight on this end of the apple more often than upon other parts of the fruit, because the calyx end is turned upward early in the season. Diseased apples are discriminated against upon the market and when any great number show cedar rust they are unfit for sale as first class fruit. If such affected apples are placed in storage they are more likely to develop rots than those free from the

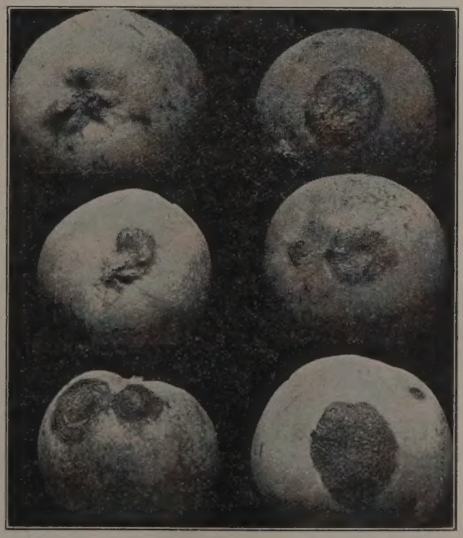

Fig. 3.—Characteristic spots of cedar rust on apples. Note the spots generally occur near the calyx end of the apples

disease. Cedar rust, however, is not nearly as common upon the fruit of the apple as upon the leaves. The chief injury which the disease does the fruit, therefore, is through reducing the leaf surface of the trees, thereby causing the fruit not to develop properly. Trees which are seriously affected by the disease and are partly or completely defoliated often are unable properly to mature their fruits, in which case the fruit is frequently so inferior it may be practically worthless.

Fig. 4.—A close view of cedar rust injury to the apple fruit.

EFFECT ON TREES

When the leaves of the apple trees are affected seriously for several years, the vigor and vitality of the trees are greatly impaired. Such weakened and devitalized trees become easy prey for diseases like blister canker, root rot and crown gall. Fruit tree borers, woolly or root aphis and San Jose scale are also able to make greater headway and do much more injury to trees suffering from a lack of nourishment on account of defoliation. Apple trees so injured generally die in a few years.

CAUSE OF CEDAR RUST

Cedar rust is caused by a parasitic fungus, the technical name of which is *Gymnosporangium juniperi-virginianae,* Schw. It has a very complex life history as well as a long, hard name.The fungus has two hosts or food plants, the red cedar and the apple, including the crab-apple. On the red cedar the fungus produces brown, corky-appearing galls which are commonly known as "cedar apples" or "cedar flowers." These galls are usually very slow in developing, and cedar trees which become infected during July and August do not usually show the effect of the disease until the following May or June. At this time the galls appear as green or greenish-brown structures on the upper surface of the cedar leaves and they do not complete their development and produce spores to infect the apple until the next spring. They require, therefore, for their complete development a little more than a year and a half. The disease is also injurious to the red cedar, and when it becomes serious it may finally kill the trees. Unfortunately, however, the susceptible varieties of apple trees are usually destroyed

by the devitalizing work of the fungus long before the red cedars suffer seriously.

In the spring, during rainy or damp weather, about the time the apples bloom, the mature cedar apples or cedar balls on the red cedars produce jelly-like horns or appendages. These appendages contain numerous teliospores which germinate, producing small spores called sporidia. Upon the drying out of the appendages following rains, the sporidia are blown to the young leaves and fruits of the apple. These spores germinate readily on the leaves and fruit of the apple under favorable conditions. The low temperatures often occurring in April and May in Missouri are very favorable to the germination of the sporidia.

As often as rainy weather occurs, the development of jelly-like masses, horn-shaped, and the germination of teliospores is repeated. With the occurrence of dry weather another crop of sporidia is scattered to the wind to be carried to the foliage and fruit of the apple. During some years not more than one or two disseminations of sporidia take place, while during other years five or six may occur. The number and frequency of the crops of sporidia produced from the cedar apples will depend upon the weather conditions. After a period of about six hours of highly humid weather, gelatinization, germination of teliospores and the production of sporidia occur. It is possible for the leaves and apples to become infected within a few hours after a short damp or rainy period.

DISTRIBUTION OF SPORES

The spores may be carried long distances, in some cases as far as five or six miles or even farther. Generally, however, they are not carried by the wind in injurious numbers over a mile and a half or two miles. Since the prevailing winds in the spring are from the west and

Fig. 5.—Cedar galls or cedar apples on the red cedar in the spring before spreading spores to the wind to infect the fruit and foliage of the apple.

southwest, apple orchards situated east and northeast of red cedar trees will generally show the greatest infection. No matter what the direction, however, if red cedar trees grow near susceptible varieties of apples and if weather conditions are favorable, the attack upon the foliage and fruit is usually serious.

In some localities of the State where apples are being grown near the red cedar, the cedar rust fungus apparently has not been introduced; at least it is not known to be present. Consequently the disease has done no damage to the fruit and foliage of susceptible varieties of apple. This fact may also account in some instances at least for apple orchards and red cedar trees growing together in earlier times without injury from the cedar rust. At the present time, however, in practically every community in the State where apples are grown extensively, the cedar rust fungus has become a menace to both the apple and the red cedar.

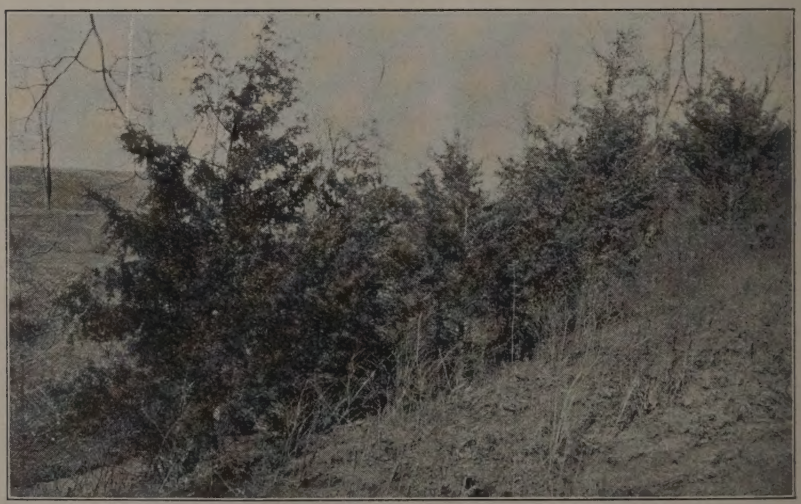

Fig. 6.—Runty, scrubby red cedar trees, growing on waste land or in fence rows are of no economic value, but they are a menace to the commercial apple industry.

GERMINATION OF SPORES

Observations and investigations have shown that the spores or "seeds" of the disease will germinate in from 3 to 5 hours and cause infection upon the leaves or fruit of the apple. Once the infection gains entrance to the leaves or fruit, spraying is of no consequence in preventing injury. The fungus develops rapidly and penetrates the leaf so that within about ten days a visible yellowish or orange colored spot may be

observed. The leaf spots continue rapid development and in about two months send out clusters of fruiting bodies on the under side of the leaf, forming cup-shaped structures. The spores produced do not reinfect the apple but are carried by the wind back to the cedar trees, where infection occurs on the tender leaves of the red cedar.

LIFE OF DISEASE ON THE APPLE AND RED CEDAR

The life of the fungus upon the apple is comparatively short, being only about three months. The variations in the life history of the fungus bring about the production of some cedar apples on the red cedar trees each year. A red cedar tree may, therefore, show cedar apples which have fruited or produced spores the previous year and some which are fruiting or producing spores during the present year, and still others which are very small and will not fruit until the following year. The life cycle of the fungus upon the red cedar requires about 21 months.

CONTROL MEASURES

Since the foliage and fruit of apple trees may become infected in the spring after each rain or period of damp weather, it is practically impossible for the apple producer to spray his orchard often enough to obtain satisfactory control of the disease. It is true that sprays as they are generally applied for the control of other diseases assist some in the control of cedar rust. Rarely, if ever, will the regular sprays be adequate when the cedar rust is serious. It is a well known fact, as every grower knows, that in the springtime the orchardist may experience, in one week, five or six or more rainy or damp periods followed by drying conditions and, consequently, as many different disseminations of cedar rust spores. Spraying is not, therefore, a practicable remedy.

The disease also differs from other fruit diseases in that the spores or "seeds" of the fungus germinate more quickly, thus requiring the application of a spray soon after the spores alight upon the foliage or fruit if injury is to be prevented. Much work has been done upon the problems of time of application and spraying materials to use for the control of the disease. These tests and experiments have shown that it is impractical and uneconomical for the grower to attempt to control cedar rust by spraying. Apple growers and investigators, therefore, are of one accord in the opinion that the only satisfactory way to prevent serious damage from cedar rust is to cut the red cedar in the vicinity of apple orchards. Since the red cedar does not sprout from the stump or stub, one cutting is sufficient. It is important that every red cedar tree be cut to a distance of 1½ to 2 miles, if satisfactory protection against the disease is to be afforded.

One small red cedar tree may spread to the winds enough spores to cause great damage to a commercial apple orchard. Where it is nec-

essary, however, to leave a few cedar trees, they may be prevented from spreading the cedar rust by carefully cutting and burning the galls or cedar apples on the red cedar trees. For the work to be effective, the cedar trees must be inspected each year from the ground to the tops and all the way around the sides of the trees; and when galls are found they should be promptly removed.

DANGEROUS DISEASES PROHIBITED BY LAW

The fruit growers and nurserymen of Missouri were responsible for placing upon the statute books of Missouri, in 1913, what is known as the "Nursery and Orchard Inspection Law." This law gives the Chief Inspector of Nurseries and Orchards full authority to prevent the spread of dangerous insect pests and plant diseases. The control of cedar rust is well within the provisions of the law as a dangerous plant disease and no doubt steps will be taken during the present year, in orchard sections of the State where cedar rust is serious, to prevent further damage.

The enactment of the state laws requiring the cutting of red cedar trees to prevent serious injury to apple orchards is not new. Several states have had such laws on their statute books for a number of years and have waged aggressive and effective campaigns for elimination of the red cedar in apple growing districts. Among these are Arkansas, Virginia, West Virginia, and New York. As with the administration of all laws, however, much more can be accomplished in any community where cedar rust is a menace if all the people concerned cooperate for their mutual good.

APPLES OR RED CEDARS?

In communities where fruit growing is important or where the apple is a great deal more important than the red cedar, there should be no question as to the cutting of all cedars within a mile and a half or two miles of apple orchards. On the other hand, if there are practically no commercial orchards in a community and the orchard business is not considered of commercial importance, perhaps it would not be wise to insist upon the cutting of red cedars near small plantings of home orchards. In such instances the varieties of apples making up small plantings might well consist of kinds which are not susceptible to cedar rust injury.

The red cedar trees which generally do the greatest harm in commercial apple growing districts are those which are allowed to grow along the roadsides on pasture lands and on rough and uncultivated waste lands. In such situation, from 30 to 40 or 50 years may be required to develop cedar trees capable of making satisfactory fence posts. No one, therefore, can question the advisability of destroying runty, unprofitable cedar trees in the neighborhood of commercial orchards, if the matter is considered from an economic point of view.